Rodenstein (C. F.)

Contributions to the

A CONTRIBUTION

TO THE

NATURAL HISTORY OF TUBERCLES.

BY

C. F. RODENSTEIN, M. D.

PUBLISHED BY REQUEST OF THE WESTCHESTER COUNTY MEDICAL ASSOCIATION.

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1871.

HAMMOND.

A Treatise on Diseases of the Nervous *System.*

By WILLIAM A. HAMMOND, M. D.,

Professor of Diseases of the Mind and Nervous System, and of Clinical Medicine, in the Bellevue Hospital Medical College; Physician-in-Chief to the New York State Hospital for Diseases of the Nervous System, etc., etc.

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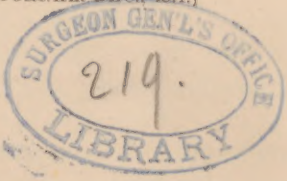

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A CONTRIBUTION TO THE NATURAL HISTORY OF TUBERCLES.[1]

The history and pathological specimens of the case I wish to report have already been laid before this Society at a previous meeting; and, if I repeat now what I said then, it is because I wish to make this case the basis of some remarks on the nature of tubercles, which I can now illustrate by microscopic preparations.

James P——, aged six years, came under my observation on the 13th of April, 1871. Of his parentage nothing could be ascertained. During the preceding winter he had been indisposed. He had a cough which was supposed to be whooping-cough, because a few paroxysms had been attended by the peculiar noise at inspiration which has given to pertussis its popular name. He became pale and emaciated. Naturally of a bright mind and lively disposition, it was noticed that he refused to go out to play, and preferred to loll about the room. He appeared at times dull and languid, at other times an unusual irritability of temper manifested itself. He frequently would seek his bed during the day; occasionally he complained of nausea. These symptoms were not of sufficient gravity to impress upon his guardians the necessity of seeking professional advice.

When the child was placed under my care, he suffered from headache, vomiting, and constipation. His respirations counted 24, and his pulse 76 beats per minute; his temperature measured 99⅓° Fahr. in the axilla.

[1] Read before the Yonkers Medical Society.

Percussion and auscultation elicited no abnormal sounds from the thoracic viscera. The abdomen was retracted, and the pulsations of the aorta could be easily felt through its parietes. There was tenderness on pressure over the region of the spleen, and the field of dulness on percussion was abnormally large. The liver seemed unaltered. The urine contained no pathological products.

During the succeeding four days there appeared no material alterations in the condition of the patient. The bowels could be moved by cathartics, but the vomiting resisted treatment. The headache was severe and persistent. The appetite was not entirely lost: milk, his only diet, as well as drugs, would be tolerated by the stomach.

On the evening of the 17th the pulse became accelerated; the temperature rose to 100⅖° Fahr. On pressure the "tache cérébrale" appeared upon the abdomen. The child became restless and moaned.

The next morning I found him comatose. The pupils sluggishly reacted to light. There was a purulent discharge from the eyes and nose. The face was pale and apathetic; occasionally a rose-colored flush would pass over it. My clinical record shows for April 18th:

	Temperature.	Pulse.	Respiration.
Morning,	102	160	58
Noon,	103½	160	52
Evening,	102⅘	160	60

During April 19th coma deepened and continued. There were oscillation of the eyeballs and convergent strabismus, the eyelids were half closed, the pupils contracted. While standing by the bedside I noticed a convulsive movement, which I took for a spasm of the diaphragm. There were singultus and well-marked risus sardonicus.

	Temperature.	Pulse.	Respiration.
Morning,	103⅗	182	60
Noon,	102⅔	164	64
Evening,	103	170	68

These symptoms became more grave during the following day. Respiration was stertorous, irregular, and distressing; the pulse was weak, rapid, irregular, and intermittent. The patient died during the night, in profound coma. The last

measurement of temperature showed 105°. There were no general convulsions in the whole course of the disease.

Fifteen hours after death a *post-mortem* examination was made. The body was found emaciated and pale. There were no maculæ emortuales. Rigor mortis was well marked. The clot in the longitudinal sinus was white and fibrinous in two-thirds of its extent. The cranial cavity contained two ounces of clear serum, and two and a half ounces of water were found in the cerebral ventricles.

On removing the dura mater, the evidences of inflammation became patent. There was considerable hyperæmia of the pia mater. Here and there patches of lymph were seen over the surface of the brain. A few isolated miliary tubercles were scattered over the crests of the hemispheres. By lifting the pia mater out of the sulci, a few more miliary granulations could be demonstrated. I have here such a small piece of the pia mater prepared for microscopic inspection. By holding the slide to the light, you can see in the centre of the preparation a small, round, and opaque body, about as large as the head of a small pin, lying by the side of a blood-vessel which has become deeply stained by carmine, and is easily recognized by the unassisted eye. The appearance of the tubercle has been considerably altered by the preservative fluid and by manipulation. In its fresh state it had a light-gray, semi-transparent look. If you place this slide under the microscope, you will recognize this tubercle only as an object which prevents the transmission of light; but, by moving it out of the field of vision, you will see it replaced by numerous round cells, some being distinctly granular; and, by a little management, you can see that they seem to congregate in denser masses along the edge of the blood-vessel which lies in the middle of this preparation.

At the base of the brain, tubercles were found in much greater abundance. This specimen is a section of the encephalon, showing its surface at the base. I have cut about an inch on each side of the longitudinal fissure, and carried the section backward nearly parallel to it, through the frontal, middle, and posterior lobes of the cerebrum, after having removed the cerebellum, and that part of the hemisphere which lies above the corpus callosum. Within a quarter of an inch

from the extreme edge of the frontal convolution you see rather small miliary tubercles dotting the course along the olfactory nerves, spreading into the fissure of Sylvius, crossing the optic tract, and stretching along toward the sides of the pons Varolii. Here they seem to have become conglomerated and formed into a denser mass, which increases in thickness as we trace it around the tubercula quadragemini and the posterior covering of the iter a tertio ad quartum ventriculum, until it forms a layer some two lines in thickness, and which has almost a cartilaginous feeling to the touch. A thin section of this mass shows it to be composed of compressed roundish cells, which I take to be identical with those we saw on the superior aspect of the hemispheres.

On opening the thorax, the pleura of each lung was found thickly studded with tubercular formations, some as small as any of those seen in the meninges, others varied in size up to that of a lentil; some were grayish white, some had a yellowish tint, some were decidedly yellow. This is the right lung. The coloring of the tubercles has been changed by alcohol, but their form and size can still be appreciated by touch and sight.

Through the anterior surface of the upper lobe a hard lump can be felt in the substance of the lung. It is about as large as a hazel-nut. I have cut through it; it looks white, has a hard consistency, and is composed of roundish cells like the concretions at the base of the brain.

With the exception of a bronchial gland, there were no other abnormal conditions discovered in the thoracic cavity. This organ, you perceive, is very much enlarged. I have made a vertical section through it, and you see here a cavity large enough for my finger to enter with ease. Its walls are covered with a soft material, which is readily removed with the handle of a scalpel, and has the look and consistency of soft cheese.

The abdominal organs appeared healthy. There were no tubercular deposits on the peritonæum, nor on the mucous surface of the intestines; the mesenteric glands were healthy, as was also the liver; the latter viscus, contrary to my expectation, revealed no tubercular cells on microscopic examination. The spleen was somewhat enlarged on its upper surface. You see still a piece of the diaphragm attached; it is

agglutinated to the capsule of the spleen by inflammatory material formed into false membrane; and, as I tear these layers of pseudo-membrane apart, one by one, you see they are thickly covered by miliary tubercles. There are none as large as the yellow tubercles of the pleura, but the most of them are larger than the isolated tubercles of the meninges.

This case, Mr. President, is of considerable interest to me: in the first place, because a correspondence between its clinical history and anatomical lesions can be demonstrated, which is not always possible; but, chiefly, because every form and variety of tubercularization can be illustrated by a specimen.

Incomplete as the history of this case undoubtedly is, especially as to its earlier stages, we have at least one salient feature which points to a specific pathological condition. The boy was supposed for a short time to have whooping-cough; that is, he had paroxysms of coughing accompanied by that peculiar, noisy inspiration which resembles the whoop of pertussis. I have, on several occasions, made the diagnosis of tubercular deposits in bronchial glands, relying upon this symptom in connection with general depreciated health in children; and I think most of the more recent authors on children's diseases give an almost pathognomonic significance to this cough when not incidental to pertussis.

A bronchial gland with tubercles in a state of cheesy degeneration was found at the autopsy to account for this symptom; and the clinical history, on the other hand, enables us to form a judgment as to the primary tubercular deposit and authorizes the assertion that this bronchial gland was probably the first organ invaded by the disease.

It is not certain whether the deposit of tubercles in the lung and pleura was attended by rational and appreciable physical signs; but if the early development of tuberculosis takes place in a state of irritation, and furnishes symptoms that can be observed, then that stage, at least as far as the thoracic organs were concerned, must have been passed when the patient was placed under my care.

The tubercular deposit between the layers of pseudo-membrane which agglutinated the spleen to the diaphragm must of course have taken place during the progress of a peri-

splenitis, some symptoms of which, tumor and pain, were still perceptible when the patient was admitted to treatment.

Whether an irruption of miliary tubercles into the meninges of the brain had actually taken place at his admission may be doubtful. Headache, vomiting, and constipation, are observed in other cerebral lesions, and in simple meningitis as well as in the tubercular variety of this disease.

But below we may adduce some considerations which may incline us to think that tubercles became developed when the temperature of the body rose as indicated by the thermometer during the last days of his illness.

However this may be, to me the chief interest in the case is this: that we have here in one subject every variety of tubercular forms. In the meshes of the meninges, and chiefly along the blood-vessels of the pia mater, we see simple tubercular cells and miliary granulations. The large gray and yellow tubercles we find scattered over the pseudo-membranes of the spleen. Among the formations on the pleura, the reticulated variety can be demonstrated. Concrete tubercular masses in bands and stripes were formed at the base of the brain. One large, round tubercle is embedded in the parenchyma of the lung; and a bronchial gland displays the so-called tubercular infiltration, or tubercles in cheesy degeneration.

The question here naturally arises, What is the relationship existing between these different forms of tubercularization? Do they represent the different stages of a process of growth? or are they separate manifestations of a morbid condition, so to speak, varieties of a pathological species? Are the miliary granulations the first stage of a process of which the infiltrated tubercles are the finale? or is the cheesy deposit the primary source of which the miliary irruption is the fatal effect? Or are they both the effects of two entirely different processes, the one a neoplastic result of cell-proliferation, the other the product of an inflammation? Such are the questions which have agitated the profession since the beginning of this century. Such are the questions which can only be answered by an inquiry into the nature and origin of tubercles.

I do not wish to enter into a general discussion of tuberculosis. I wish to confine myself to a single topic—which, however, will give to this whole subject a different aspect

from that in which it is generally contemplated; and, to express at once, in one proposition, all that I have to say on this subject, I wish to prove the identity of the cellular element of tubercles with the white corpuscles of the blood.

You may recollect that, some two years ago, in a discussion which followed the reading of Dr. Bowles's paper before this Society, on the modern views of the pathology of phthisis pulmonalis, I expressed the opinion that the origin of tubercles would ere long be traced to an extravasation of white corpuscles of the blood. At that time I did not know that William Addison had already advanced that proposition in 1843. With the vast advances made in medical science by microscopic investigation, of which both the cellular elements of the blood and of tubercles have so frequently been the subject, it seems strange that Addison should have had no followers, and that his views should have been so generally overlooked or neglected. Waldenburg has indeed lately suggested, among the hypotheses that might explain the results of his tubercular inoculations, that Cohnheim's theory of the emigration of white corpuscles might explain the presence of lymphoid cells in tubercular deposits; but he has failed to identify the one with the other; and yet to do so would seem to be the logical and inevitable result of his observations, as we shall see hereafter.

By microscopic appearances it is impossible to distinguish separate tubercular cells, such as we see scattered over the pia mater, from white blood-corpuscles. In every anatomical feature they are identical. It is true, both in text-books and in the lecture-rooms of eminent medical schools, the size and shape and nuclei of tubercle-cells are contrasted with those of the colorless cells of the blood. The same has been done in descriptions of pus-corpuscles; and yet who will now maintain that there is a structural difference between pus and white blood-corpuscles?

Virchow's fullest description of a tubercular cell is given in his great work on "Morbid Tumors," vol. ii., p. 637. "The true tubercular corpuscle is a real cell," he says; "neither a mere nucleus nor a solid body. Like leucæmic, typhous, and scrofulous cells, it resembles in all essentials the elements of lymphatic glands. It is a round cell of very variable size,

generally smaller than the colorless corpuscles of the blood; sometimes, however, larger, double and triple their size. The cell-body is colorless, transparent, feebly granular, easily injured, so that it may be destroyed by pressure or section, by the addition of water or other fluids. In the interior of the fully-developed cell there is a single nucleus, small, tolerably homogeneous, frequently shining, which sometimes, however, is larger, distinctly granular, and furnished with nucleoli. Larger cells contain at times two or more nuclei, yes, sometimes twelve and even more. The multiple nuclei are often small and smoother, but not always in the same cell of equal size, sometimes quite large and granular." Now, this definition is as admirably descriptive of pus-cells as it is of tubercular cells, and all these variations of form and color and contents were considered as sufficiently characteristic to distinguish them from the colorless blood-corpuscles, which were believed to be less variable at least in size. But Max Schultze, who has lately devoted himself to the study of the cellular elements of the blood, informs us that he constantly observes (and the observation can be verified by every one as soon as attention is directed to this subject) that there are colorless corpuscles in the blood which do not attain the size of the red corpuscles; that they are round cells, containing *one* or two nuclei; that there are others much larger, containing also only one or two nuclei; others which contain more, some of which are finely granular, others coarsely granular; that the nuclei of some are more homogeneous than others; and, again, that some have nucleoli and others not. We have, therefore, here again all the characteristics of the pus and tubercular cells. There is, however, one characteristic which is the most striking and wonderful quality of the white blood-corpuscle, and this is its power of locomotion: it is rather this physiological function, than any anatomical structure, which has enabled modern microscopists to recognize the identity of the white corpuscles of the blood with lymphoid cells in other tissues. Since the discoveries of Von Recklinghausen, they are spoken of as contractile migratory corpuscles or amœboid cells. Now, tubercles are generally only seen after death, and of course amœboid motion is as utterly out of the question as muscular motion. But there is at least one organ in which tubercles

can be seen during life, namely, the eye. Whether there were such tubercular deposits in the case I observed, could not be ascertained. Ophthalmoscopic observations were impracticable, and *post-mortem* examination had to be avoided on account of the necessary mutilation. But there are now quite a number of cases on record in which tubercles were observed in the choroid. Manz supposed them to be proliferations from the cells of the adventitia of the blood-vessels. Bush, however, found nothing which would confirm this opinion, and assumed, as they must be the results of cell-proliferation, that they came from the large unpigmented stroma-cells of the choroid. But Cohnheim, who reported seven cases which had been under his observation, says tubercles of the choroid proceed neither from the nuclei of the capillaries nor from the large unpigmented stroma-cells, but from a third kind of cells, which are found beside the pigmented and unpigmented stroma-cells; they are small, pale, finely-granular cells, of the character of lymph and pus corpuscle—in short, the contractile migratory cells of Von Recklinghausen.

There is nothing, therefore, in the morphology of tubercular cells, as far as it can be ascertained by the most expert microscopists, which militates against their identity with the white corpuscles of the blood.

The locality of tubercles also favors the presumption that their cellular elements are derived from the blood. They are generally developed along the course of the vessels. This fact has been noticed by many observers. Some, indeed, have assumed that they were developed from the sheath of the arteries or the cells of the capillaries. Others, it is true, have thought that they were proliferations from the epithelium of the lymphatics. And certainly formations similar or identical with tubercles, especially the so-called reticulated tubercle, are seen along the tract of the lymphatic structure. Wagner has lately described these formations in an admirable monograph, and denominated them *lymphadenoms*. Those cellular elements are certainly the same as those of the tubercular corpuscle. And whether there is a real difference between a tubercle and a lymphadenom or not, lymph-corpuscles and tubercle-cells being identical, the occurrence of lymphoid neoplasms within the immediate neighborhood of lymphatic

organs would in no way interfere with the assumption that the miliary granulations along the blood-vessels derived their cellular constituent from the blood.

But that illustrious teacher, whose genius has created the cellular pathology, rejects, with all the force of his matchless eloquence, the theory that tubercles are derived from the blood, and insists with the utmost positiveness that they are proliferations from connective tissue. The name of Virchow stands so high that, to question his opinions in pathological anatomy, almost implies ignorance or presumption. And yet in his cellular pathology he taught, with the same wealth of illustration, with the same eloquent positiveness, that pus-corpuscles are derived from connective-tissue cells; and yet, notwithstanding this, he gave his adhesion to Colnheim's theory as early as 1867, in a paper read before the meeting of the German Naturalists, at Frankfort-on-the-Main, if I understood him rightly. Perhaps he will also change his views on the origin of tubercles.

At all events, for my purposes, I could not find a better specimen to illustrate the formation of tubercles from the migratory cells of the blood than that of which Virchow gives a picture to prove the opposite theory. (*Vide* "Krankhafte Geschwülste," vol. ii., p. 633.)

This represents a tubercular formation within the sheath of an artery taken from a case of tubercular meningitis. At its lower end you see the sheath pretty closely adherent, and showing somewhat enlarged fusiform cells; as we ascend the artery we find the sheath more and more distended by an increasing accumulation of small round cells. Virchow assumes them to be proliferations of the connective-tissue cells. But a mere look at this picture suggests to me a much more natural explanation for the presence of these round cells between the coats of the vessel. At a closer inspection you see that the middle coat also is studded with the same round cells, which seem to dissect off the outer membrane, and that these same round cellular structures adhere to the free surface of the inner coat. Now, it seems to me it is much more natural to suppose—knowing that amœboid cells are disposed to migrate—that these cells are in the act of leaving the blood-vessels, than that they originated outside of the muscular coat

and penetrated the artery from the adventitia. And, if you will only look at the outlines of the sheath, you cannot fail to notice at least three places where the round cells seem to be in the very act of breaking through the outer coat to escape into the surrounding tissues.

I have here a preparation for the microscope, by which I thought I might illustrate this process; unfortunately, it has been spoiled by asphalt in mounting. But no preparation can show the escape of cells from blood-vessels more beautifully than that which is represented in this woodcut. Had I made the drawing, it might be suspected that preconceived theory guided the pencil; but this is Virchow's book. He prints this picture to prove the proliferation of tubercular cells from connective-tissue cells. But is not mine the most obvious and natural explanation of what we see there?

Another consideration, which I think will confirm the conclusion at which I have arrived, is, the existence of tubercles in and between the layers of pseudo-membranes. I am well aware that this very fact has been claimed as a proof that tubercular cells are directly derived from connective-tissue cells. But I could never see the force of such argument. For while it is true that false membranes are poor in blood-vessels, and that their existence cannot always be demonstrated, it by no means follows that, therefore, tubercles found in false membranes must be derived from some other source than the blood-vessels. For instance, the layers of pseudo-membrane which agglutinated the spleen to the diaphragm, in the case under consideration, are thickly studded with tubercular formations, yet it is impossible to show them to be vascular; they are quite fresh, easily separated, the products of a recent inflammation. But, while they may not possess blood-vessels, they are themselves the products of exudation. The organized material and the organizing element came both from adjacent blood-vessels. And, assuming that tubercular cells are identical with the white blood-cells, is it such a stretch of the imagination to believe that they came along with the inflammatory exudation and formed into tubercles, while the other elements of the blood were organized into membranes?

I must guard myself here against a misunderstanding. I do not wish to return to the theory of Broussais and Andral

and other French pathologists, and maintain that tubercles are an inflammatory exudation. For, while I think it most consistent with clinical observation and anatomic pathological facts to assume that tubercular cells are deposited during an inflammatory process—an opinion which has also the support of physiological experiment, for the amœboid movement of the white blood-corpuscles becomes exceedingly lively as soon as the temperature is raised to 39 or 40° Centigrade—it does not follow that, therefore, they are the products of inflammation; that is, that they are developed out of the blastema, which was supposed to become organized either into false membrane or pus. Tubercular cells may transude from the blood with inflammatory material, as Rokitansky supposed, without being themselves inflammatory in character.

I know it is very difficult at this moment to formulate a satisfactory theory of inflammation. For, while it is impossible to rest satisfied with the old definition of "rubor, calor, cum tumore et dolore," the newest ideas evolved by Cohnheim's discovery are not sufficiently developed to form the basis of an exhaustive definition of that pathological process, which all recognize as a clinical fact, and call inflammation. At present we are still compelled to be contented with saying that the effusion of serum, lymph, and pus, and the formation of false membrane, under an increased temperature, are inflammation. Now, during this process, tubercular cells may be also exuded from the blood-vessels, and yet be not inflammatory product. This may at first seem to be a mere logical quibble. For, as pus-corpuscles are only emigrated white blood-corpuscles, and tubercular cells are emigrated white blood-corpuscles, and the first, according to the received definition, are inflammatory products, it may be said that tubercles are also inflammatory in fact, although in mere definitions they are not enumerated among the exudations.

But white pus, white blood-corpuscles, etc., are essentially the same structures, and cannot be distinguished either by anatomical or physiological characters; in fact, are one and the same thing. There is a pathological cause, which in the one instance makes of a white blood-corpuscle a pus-cell, and in another a tubercular cell, in the same way as a pathological process may make one man a dyspeptic and another an epileptic,

and both be men still. Or, as, in embryological development, there is a physiological tendency which causes one cell to become an astroblast, and another of identical structure to become a connective-tissue corpuscle, so is there a pathological tendency which causes one amœboid cell to become a pus-corpuscle, and another a tubercular cell. And, although pus and tubercular cells are identical in healthy blood, and are transuded in inflammation, it is as improper to say that tubercles are only a collection of pus as it is to say that a leucæmic, or typhous tumor, or a glioma, is a collection of pus, notwithstanding that each is made up of round migratory cells. For the characteristic of a tubercle is not that it is made up of round cells and nuclei, but in that it is tubercle, a distinct neoplastic formation. For, as a glioma is a neoplasm, though its cellular element is largely made up of lymphoid cells, and these cells may have emigrated from the blood-vessels during a retinitis, which may have been the first starting-point or occasion of a gliomatous growth, so is a tubercle a neoplasm, although its cellular elements may have escaped from the blood-vessels during a pneumonia or a meningitis.

The organization of tubercles is of the simplest form. They are not vascular; but vascularity is no longer deemed the essential feature of an organism. If blood-vessels are seen in tubercles, they are not of a new growth. They are the old vessels from which the tubercular cells exuded, and which become obliterated generally by pressure. Now, if we accept the results of Wagner's investigations, and exclude from tubercles, lymphadenoms—the so-called reticulated and encysted tubercles—we have but one type of organization left as characteristic of tubercles, namely, round cells embedded in a hyaline matrix. Whether the tubercular cells, after they have left the blood-vessels, proliferate and, so to speak, grow into miliary tubercles, and the miliary granulations develop into larger tubercles by endogenous growth, or whether the size and form of tubercular deposits depend upon the accumulation of lymphoid cells, and are conditioned rather by external circumstances, such, for instance, as the nature of the tissues into which they are poured, cannot yet be determined.

In making experiments with blood-corpuscles, I have lately noticed that, if a drop of blood, freshly drawn, be placed in

an alkaline solution of carmine, the red corpuscles lose their power of forming rouleaux; and the white corpuscles absorb the carmine, seek each other, congregate in little masses, and seem to become agglutinated to each other. I have here a drop of blood prepared for microscopic inspection. By careful focussing, you can still see the whole field covered by fine little rings which seem to form a delicate net-work, looking somewhat like the cornea of a fly seen with a low power; this is nothing but the red corpuscles of the blood which touch each other by their edges. Scattered over this delicate, pale net-work, you can see, here and there, little, bright-red, cellular masses; these are the white corpuscles of the blood tinged with carmine. In specimens of pathological urine, I have also seen sometimes, under the microscope, that pus-corpuscles have a tendency to approach each other, and to form adherent masses.

Perhaps the formation of miliary tubercles takes place in a similar manner. The amœboid cells, when leaving the circulation, may bring with them a tendency to form into granulations; or the chemical or physical condition of the surrounding tissues may determine them to assume the form of minute nodules. We find sometimes, with these semi-transparent bodies, others rather of a fibrinous structure; they may represent a subsequent stage in the development of tuberculari-zation. The lymphoid cells may have changed into fibrinous tissue by progressive metamorphosis. Virchow thinks that the fibrinous tubercle represents the first stage of tubercular growth, which has not yet unfolded itself into the full-blown cellular tubercle. Langhaus, on the contrary, looks upon this formation as the full development of the cellular tubercle, and describes it as consisting of three zones, formed by the transformation of round cells into fibrillæ. Whether such bodies can be distinguished from minute fibromas, or whether the one or the other be the earlier stage of a continuous development, the tendency of all tubercular deposits to speedy decay has been universally recognized. Virchow says: "This structure, which in its development is most nearly related to pus, inasmuch as it has the smallest nuclei, and relatively the smallest cells, is distinguished from other more highly-organized forms of cancer, cancroid, and sarcoma, by the circumstance that

these contain large voluminous corpuscles, with highly-developed nuclei and nucleoli. Tubercles, on the contrary, are always a pitiful production, and from the very outset perishable." And in this respect, also, tubercle betrays its origin and nature. The common characteristic of all formations in which the lymphoid cell-element predominates is to cheesy degeneration. Inspissated pus, a scrofulous gland, a lucæmic tumor, typhoid deposits, the exudation of a catarrhal pneumonia, all have a tendency to terminate in tyrosis. And, like them, the ordinary termination of tubercular deposits is in cheesy disintegration.

If any further proof were needed to establish the identity of tubercular cells with white blood-corpuscles, it would be furnished by the experiments lately made to ascertain the inoculability of tubercles. Many varieties of domestic animals have been used for that purpose. Tubercular and other pathological matter has been inoculated, and in a large percentage of cases resulted in tuberculosis. Villemin first succeeded in 1865 in producing miliary tubercles artificially; since that time many other experimenters have been equally successful. Langhans and Bejin alone deny that the nodules seen in the inoculated animals were true tubercles, but only because they differ from other observers in the definition of tubercles. The latter, for instance, in describing the *post-mortem* appearances of one of the animals inoculated by him with tubercle, says: "The mesenteries were thickly strewn with small, gray, semi-transparent nodules, which, under the microscope, showed granules and small cells of the sizes of the colorless corpuscles of the blood, with large nuclei, sharp outlines, and destitute of fat." Now, this is exactly what others call miliary tubercles.

Most of these experiments were made to ascertain the specific infectious nature of tubercles. While some follow Villemin, and maintain it, others have inoculated with non-tubercular matter and still produced tubercles; and they, of course, maintain the non-specific nature of tubercles. With this question we have nothing to do at present. But among the indifferent substances used was aniline blue. Waldenburg, indeed, reports a case where nothing but aniline was injected, and produced tubercles. Other experimenters have mixed aniline blue with the matter which they inoculated, and, in

those cases in which tuberculosis followed, it was found, after death, that the tubercles contained aniline blue.

Now, we know that the white corpuscles of the blood possess the power to swallow and incorporate into themselves finely-granular coloring matter. Cohnheim's experiments were based upon this fact. He injected aniline blue. He knew the white corpuscles would absorb it; and when, afterward, he found pus-cells containing blue granules in the cornea and the mesenteries, where he had produced an artificial inflammation, he inferred the identity of pus corpuscles and the colorless elements of the blood.

And if this conclusion is valid, then also must it be granted that the presence of aniline in tubercles, artificially produced by inoculations holding aniline, proves the tubercular cells to be identical with the white corpuscles of the blood.

At the conclusion of a paper devoted to the discussion of a single topic, it is impossible to point out the full bearing of these views upon the current opinions on the general subject of tuberculosis. And yet I may be permitted, perhaps, merely to intimate that their adoption might lead to a reconciliation of the conflicting theories of the schools. If the cellular elements of tubercles would be recognized as emigrated white blood-corpuscles, the question whether tubercles be of an inflammatory origin, or of heteroplastic growth, would lose its significance. For, while, on the one hand, the blood-vessels would be acknowledged as the source of the constituent elements of tubercles—and that is all that the advocates of the inflammatory hypothesis can maintain, for a tubercle as such, in its entirety, cannot be an exudation—on the other hand, the organization of these cellular elements into tubercles would still partake of the nature of an heterologous neoplastic process; for these formations would be built up of other cells than those which naturally belong to the tissues in which they are found.

Nor could there be any longer any dispute as to what constituted the characteristic form of tubercles, the miliary granulation of the infiltration. Both being essentially composed of round lymphoid cells; both coming originally from the blood; both having the tendency to cheesy degeneration;

both being the products of that general pathological tendency which causes the white corpuscles to emigrate, and to assume different forms in different locations—there would be no difficulty in granting both to be truly tubercular, although the one may never have been miliary, nor the other infiltrated.

Even the older controversy between the solidists and humoralists might be settled by a compromise; for, while tubercles are certainly derived from solid elements, the tendency, the real pathological moving power, which causes a white blood-corpuscle to become a tubercular cell, may reside in the fluids, and be the result of physical conditions or chemical changes, for which our reagents are not subtle enough, and our science is too clumsy to demonstrate.

The recognition of the identity of tubercular cells with the white corpuscle of the blood would save us from the reabsorption theory, which at this moment threatens to become the favorite hypothesis of the day. Modern surgical pathology has just delivered us from the terrors of the unknown, by differentiating pyæmia from septicæmia, and explaining the nature of both. And scarcely have we recovered from the nightmare of an undefined purulent absorption, when we are asked to embrace again the former loose and indistinct notions of pyæmiæ, and call them tuberculosis. As soon as we believe that the tubercular cells are blood-cells, we need not to assume the existence of "foreign centres of corpuscular infection," and claim the blood as a transporting medium. It is not so easy to prove the origin of tubercles by infections as some are inclined to think, by seeing the results of artificial inoculation in animals. I have no doubt that, while reading this paper, some gentlemen have thought the case which forms its basis an admirable illustration of this theory; for clinically and anatomically it can be demonstrated that the bronchial gland, found *post mortem* in a state of cheesy degeneration, was the first organ attacked; and the inference is tempting that the other organs became affected by tubercular deposits, through infection from this gland. But this bronchial gland itself was the seat of tubercular deposits—and whence was it infected? I have no doubt an ardent resorptionist might have found a primal source of infection. Nowhere is the scriptural promise, "Seek and ye shall find," so universally

fulfilled as in medicine. And in this case it might have been discovered that the boy had had a catarrh or a boil somewhere, as who has not? But how wide and how wild is the inference that any catarrhal or purulent secretion may become the source of tuberculosis!

Again, the views which I have advanced may enable us to estimate the degree of malignancy to be attributed to tubercles. The large conglomerate tubercle of the brain or other organ may prove fatal by mechanical pressure; but most persons suffering from tuberculosis die of phthisis or meningitis. It is the inflammatory process, of which miliary granulations or cheesy transformations are the accompaniments, which destroys the patient. I question if there is any inherent malignancy in tubercles as such. And instead of saying, with Niemeyer, that the worst thing that can happen to a phthisical patient is his becoming tubercular, I would say a man might stand his tubercles, if they were not the accompaniments or causes, or both, of a pneumonia, a meningitis, an enteritis, or a nephritis.

In closing this paper, I cannot repress the reflection that the adoption of these views would exert by far the most important effect upon us, as practising physicians, by throwing a ray of hope over the field of therapeutics. Virchow has pointed out that cheesy degeneration is the common but not necessary termination of tubercles. Some undergo fatty degeneration, and are absorbed. We have learned that cheesy pneumonia may terminate in recovery; and if there is no malignant omen inherent in tubercles, then cheesy pneumonia, even if undoubtedly of tubercular origin, may not necessarily be fatal. Such considerations will stimulate to new endeavors to devise means for the prevention of tuberculosis, or to limit its devastations. I do not believe that the consumptive will find a cundurango-tree any more than the cancerous patient. But I know that science is progressive, and that the limits of our art have not been reached. Nature may have no specifics; but the tree of the medical knowledge of good and evil will still blossom, and bear golden and abundant fruit for the healing of the nations.

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